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## Inside the black box of Agricultural Innovation Projects

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# Chapter 1

## Introduction

The ‘licence to operate’ of Dutch agriculture is being challenged due to persistent environmental, public health, animal welfare, and spatial pressure problems (Beekman, 2008; Driessen, 2010). Increasing use of agro-chemicals, pesticides, and antibiotics, and the outbreaks of veterinary diseases, scaling up of land use and increasing ethical concerns about animal welfare urge the need for a more sustainable agricultural sector in The Netherlands. To change the sector into one that combines animal & human well-being and a sustainable rural environment with economic viability is the challenge for the next decade(s).

Despite numerous promising efforts (e.g. regulations, R&D programmes, subsidies, and local initiatives), the development of more sustainable practices and business models in the agricultural sector is proceeding slowly. It is argued that several factors underlie this slow transition (Geels, 2005; Grin, Rotmans and Schot). First, experience shows that the needed change does not come about through single track interventions initiated either from policy, research or the business community. Second, and in addition, most of the current efforts show a disconnection between policy, research and local businesses. Third, the current efforts often focus too much on single, well-defined topics (e.g. either on improving pig welfare or on decreasing phosphate and nitrate emissions). To realise desired changes in the agricultural sector an integral, collaborative and multi-level approach involving farmers, policy-makers, researchers, community members and opinion leaders is needed. Such an approach aims for a cascade of technical, practical and cultural changes within the sector, which is referred to as system innovation.

This thesis explores initiatives that aim to contribute to agricultural system innovation in order to realise a more sustainable sector. Specifically, it aims to contribute to:

- I. The *theoretical understanding* of agricultural system innovations.
- II. The understanding of the *guidance* of agricultural innovation projects.

This chapter starts with a description of the development of Dutch agriculture and elaborates on the sector and its current limits (section 1.1). Next, relevant

concepts in the field of system innovation and science and technology studies are explored (section 1.2). In section 1.3 understudied issues and related research questions are identified. The research on which this thesis is based is conducted using a case study approach. An introduction of the five studied cases, a clarification of the research methodology and an overview of the data collection is provided in section 1.4. Last, a reading guide is included in section 1.5.

### **1.1 Background: the Dutch Agricultural Sector**

From the 19th until the end of the 20th century, Dutch agricultural policy was aimed at intensifying food production. After the famine that prevailed during World War II, the government invested heavily in agricultural knowledge infrastructure with the aim of modernising the agricultural sector. The infrastructure of Dutch agricultural knowledge is referred to as the 'Education, Extension and Research (EER) triptych' (OVO drieluik). It incorporates research and development (R&D) organisations, such as an agricultural university, applied and strategic research institutes, experimental stations and demonstration farms. Researchers of these institutions monitored the agricultural sector and developed and tested new technologies, processes and products. The extension programmes included specialists and regional fieldworkers, who were responsible for the rapid diffusion and implementation of new knowledge, information, technologies, processes and products within the agricultural sector. In addition, there were several agricultural schools to educate the future generations of farmers (Grin, 2010; Leeuwis, et al., 2006). The EER triptych contributed to "the Netherlands becoming the second largest exporter of agricultural products in the world around 1980" (Leeuwis, et al., 2006, p. 7).

Today, the Dutch agricultural sector is, when compared to other countries, highly productive and efficient. More than two thirds of Dutch vegetables, fruits, flowers, pig meat, poultry, eggs and dairy products are exported around the world. Although modernisation of agriculture resulted in high availability of food in the Netherlands, it also gradually led to numerous unforeseen negative side effects, including environmental, public health, animal welfare and spatial pressure problems.

Environmental problems arise from farmers applying chemicals, such as pesticides, and from animals emitting nutrients such as CO<sub>2</sub> and NO<sub>3</sub>, which pollute soil, water and air. Rachel Carson's landmark book 'Silent Spring' (1962), about the disastrous

effects of agricultural pesticides on birdlife, opened the eyes of many and since the 1970s public awareness of the negative environmental side-effects of agriculture has steadily increased. In the 1980s the polluting effects of manure became visible to the public as trees were losing their leaves and needles due to acid rain (Grin, 2010). The contribution of agriculture to Global Warming (18 % of the greenhouse gases emitted due to human activity according to Steinfeld et al., 2006) is less visible but often cited in public media. In addition, the risk of transmission of infectious diseases from animals to humans gains public attention. Over the last fourteen years hundreds of people died due to outbreaks of BSE (mad cow disease), avian influenza (bird flu) and EHEC infections. Furthermore, intensive animal husbandry sparks fierce public debate about animal welfare (Eijssackers and Scholten, 2010). Representatives of the Dutch Party for the Animals (in Dutch: 'Partij voor de Dieren') placed ethical concerns about animal treatment within intensive agriculture, which they consistently refer to as 'factory farming' (in Dutch: 'bio-industrie'), high on the political agenda.

In addition, the Dutch agricultural sector is confronted with increasing international competition. The resulting pressure on profit margins leads to an increase in scale of the farms (Bruchem et al., 2008; LEI and CBS, 2011). A press release of the Statistics Netherlands (in Dutch: 'Centraal Bureau voor de Statistiek') (van der Wal and de Rooij, 2010) on the basis of the Dutch agricultural data (LEI and CBS, 2011) states that from 1995 to 2009 the total number of Dutch farms dropped with 36 percent to approximately 73,000 farms, while at the same time production rose by 15 percent. In 2009, the average farm comprised 50 percent more land than in 1995 (van der Wal and de Rooij, 2010). Several NGOs and public actors criticise the trend of scaling-up farms as they see it as an extension of the kind of modernisation and industrialisation which caused the unforeseen environmental issues in the first place. An example of this view is the video clip 'the Meatrix' (TheOfficialMeatrix, 2006, [http://www.youtube.com/watch?v=qSqAMt\\_C7kw](http://www.youtube.com/watch?v=qSqAMt_C7kw). Accessed at 5 June 2011).

The issues mentioned above contributed to the public appeal of the sustainable development of the agricultural sector. In response, agricultural policy nowadays aims at achieving an agricultural production sector that is not only economically robust, but also environmentally and animal- and socially friendly (Bos, 2008). Since the 1980s, the Dutch government has endeavoured to motivate the agricultural sector not only to focus on increasing the scale of production but also to pursue alternative directions such as precision agriculture, agriculture that is

energy and waste efficient, multifunctional land-use, and biological agriculture. Despite numerous government policies, agricultural change proceeded slowly. Leeuwis et al. (2006) argue that the Dutch government started to regard agricultural knowledge infrastructure (including the EER triangle) as an obstacle rather than a stimulant to transform agriculture into a more sustainable sector. The government argued that new market-oriented research, development and innovation programmes were needed to contribute to the sustainable development of agriculture.

A selection of innovation programmes that were recently (within 21<sup>st</sup> century) funded include: Innovation Network (in Dutch: 'InnovatieNetwerk') (Grin and van Staveren, 2007), TransForum (van Latesteijn and Andeweg, 2010) and Cluster Sustainable Production and Transition (in Dutch: 'koepel cluster Verduurzaming Productie en Transitie'). The research on which this thesis is based is executed in the context of the innovation programme TransForum. During its grant period (from 2004 until 2010), TransForum supported over thirty *innovation projects* with the aim to contribute to the sustainable development of agriculture. In innovation projects pioneering entrepreneurs, researchers and other actors jointly shape new products, processes and technologies (i.e. novelties) to achieve a more sustainable chain of food production.

TransForum endorses a system innovation perspective as they state that: "sustainable development is a dynamic process [which] needs system innovation" (van Latesteijn and Andeweg, 2010, p. 13-14). The core working strategy of TransForum is "to let practice lead!" (Veldkamp et al., 2009, p. 89). By initiating innovation projects they provided: "the necessary trial and error spaces. [...] which enables entrepreneurs to explore yet uncertain opportunities, and learn from them" (Mommaas and Eweg, p. 47).

An underlying assumption of TransForum's approach is that successful innovation projects may trigger others to innovative which, in turn, may lead to a cascade of technical, practical and cultural changes within the sector. Thus, innovation projects may, in time, result in system innovations that transform the agricultural sector into a more sustainable sector. This is why I refer to the projects in the context of TransForum as innovation projects rather than *system* innovation projects; system innovations may be the result of a collection of these types of projects. Others in the field have referred to similar projects as transition experiments (e.g. Bosch, 2010), system innovative projects (e.g. van Mierlo, 2010),

pioneer projects (Meijer, 2008), demonstration projects (Schot and Geels, 2008), niche experiments (Grin, 2008; Kemp and Rotmans, 2004) and innovative practical projects (van Latesteijn and Andeweg, 2010). This group of projects all aim to realise actual change that can potentially contribute to system innovation.

Managing innovation projects is an inherently contingent process, that is, there is no 'recipe' or 'blueprint' to follow. Moreover, since little prior experience exists on how to guide system innovations, innovation projects can be regarded as exploratory spaces in which actors experiment with 'agricultural system innovations'. In the next section I elaborate on this system innovation perspective in order to place the programme and projects studied for this thesis in their theoretical context.

## **1.2 System Innovations**

System innovations can be defined as "changes in both established patterns of action and the structures in which they are embedded" (Grin, 2010, p. 224). Historical examples include the transition from sail to steam ship (Geels, 2002), from horse to car (Geels, 2005), from coal to gas (Geels, 2005) and from cesspools to sewer systems (Geels, 2006). System innovation are "long term process that covers at least one generation (25 years)" (Loorbach 2007, p. 18).

### **Multi-Level Perspective**

Building on work of Rip and Kemp (1996) and Kemp et al. (2001), Geels (2002) developed the multi-level perspective model to conceptualise the process of system innovations. The multi-level perspective distinguishes three levels: the niche (micro-level), the regime (meso-level), and the landscape (macro-level). Geels (2002, p. 1259) emphasises that: "the different levels are not ontological descriptions of reality, but analytical and heuristic concepts to understand the complex dynamics of socio-technical change".

The regime represents the dominant socio-technical system with shared routines, which are formalised through institutional rules or embedded as norms. The resulting patterns prove remarkably resistant to radical change. Or as Geels (2002, p.1258, referring to Freeman and Perez, 1988) notes: "Radically new technologies have a hard time to break through, because regulations, infrastructure, user practices, maintenance networks are aligned to the existing technology. New

technologies often face a mismatch with the established socio-institutional framework". Therefore, a crucial role in any system innovation process is played by so called niches.

Niches are sheltered spaces in which actors can experiment with radical new products, processes, and technologies that are considered desirable. In the remainder of this thesis I specify such new products, processes, and technologies as *novelties*, to discern them from the general concept of an innovation because an innovation may refer both to the new products, processes, and technologies and to the process of change. Niches act as incubators in which actors develop and experiment with novelties that are considered promising. When relating the multi-level perspective to innovation projects, it becomes apparent that innovation projects operate at the niche level (micro-level) as (a) innovation projects are partly sheltered from regime level dynamics such as market conditions because usually they are publicly financed and (b) in innovation projects actors aim to develop, implement, and scale-up specific novelties that could contribute to fundamentally changing the agricultural sector into a more sustainable sector. A general notion within system innovation studies is that novelties are predominantly introduced and developed by a small network of dedicated actors who are new entrants (newcomers). These newcomers are not embedded within the dominant socio-technical regime.

The landscape level refers to national or global conditions, such as economic or environmental circumstances. Current trends within the landscape include global warming, the international economic crisis, urbanisation and the information (or digital) revolution. Such landscape developments are often, but not always, long-term trends that influence (and sometimes exert pressure on) both the regime and the niche level.

The analytical model is referred to as the 'multi-level perspective' to emphasise that niches (micro-level) are nested in regimes (meso-level), which are in turn nested in the landscape (macro-level). The arrows in the diagram of the multi-level perspective (figure 1.1) refer to the process of variation and selection of various types of novelties.

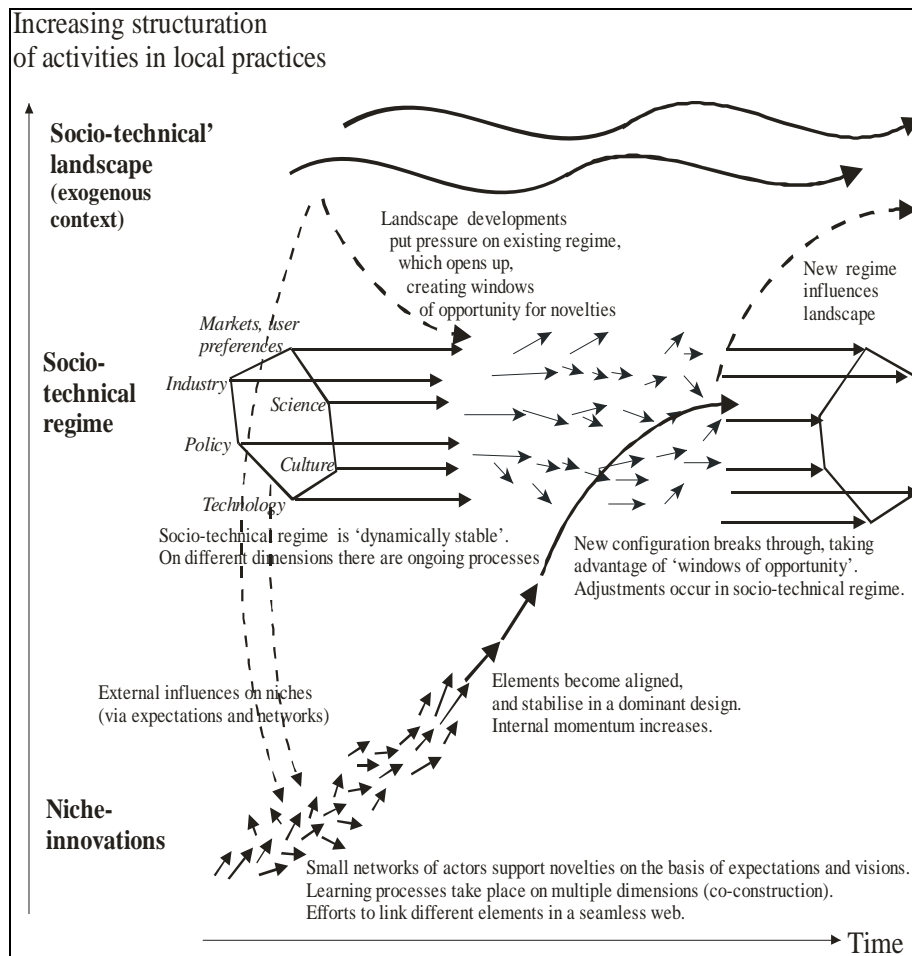


Figure 1.1: Multi-level perspective on transitions (adapted from Geels, 2002, p. 1263) (Geels and Schot, 2007, p.401).

In response to critique from, among others, Smith, Striling and Berkhout (2005), Geels and Schot (2007) refined the multi-level perspective. They propose four 'archetypes' of transition pathways. These four types are the result of taking into account two variables. The first variable is whether the niche and landscape *reinforce* or *disrupt* the regime. The second variable makes a distinction between the relationship that the regime has with the novelty; it can be considered as either *competitive* or *symbiotic*. Geels and Schot (2007, p. 406) propose that: "Niche-innovations have a competitive relationship with the existing regime, when they aim to replace it. Niche-innovations have symbiotic relationships if they can



be adopted as competence-enhancing add-on in the existing regime to solve problems and improve performance”. Depending on the combination of these two criteria the following pathways can be distinguished: transformation, reconfiguration, technological substitution, and de-alignment and re-alignment.

In the transformation pathway, moderate disruptive pressure from the landscape (macro-level) triggers regime actors to reorient. In response to these outside pressures, symbiotic relations are formed with add-on novelties, which will gradually adjust the regime. In this pathway: “Niche actors thus acted as front-runners, whose routines and practices gradually trickled down and changed regime rules” (Geels and Schot, 2007, p. 406). In the reconfiguration pathways the regime adopts ‘beneficial’ novelties that are developed in niches; hence creating a symbiotic relationship. (I will discuss this pathway in detail in the next paragraph). Within the de-alignment and re-alignment and technological substitution pathway the regime has a competitive relationship with the niche. In the de-alignment and re-alignment pathway strong and sudden disruptive landscape pressures lead to a collapse of the regime. The broken down regime provides room for the development of novelties, which are already present in niches. Technological substitution occurs when developments within niches break through the regime and replace the existing socio-technical structure. In the conclusion of the paper, Geels and Schot (2007) note that the pathways are not deterministic and should be perceived as ideal types.

### **Reconfiguration Pathways in the Agricultural Sector**

Geels early work (2002) focuses on disruptive system innovations in which specific technologies ‘break through’ the regime and ‘replace’ it. However, it is questionable if such a revolutionary substitution-perspective is appropriate for agricultural system change, among others because agriculture is not structured around a ‘core’ technology. Moreover, the agricultural sector is characterised as a widely distributed, loosely linked, non hierarchical, international network of specialised small and medium-sized enterprises (SME), which makes it a comparatively resilient sector.

Berkers and Geels’ (2011) historical case study on system innovations within the Dutch greenhouse horticultural (1930-1980) sector illustrates that system innovations within the agricultural sector entail a long-term step-wise process. Their study describes that the structure of the greenhouse horticultural sector was

gradually transformed as growers incorporated diverse *add-on* novelties within their business. In line with this research Driessen (2010, in press) observes that: "farmers often do not change their entire facilities at once as in large-scale industrial systems, they improve on their farming technologies by piecemeal engineering, in that way spreading investments". In the Dutch greenhouse horticulture case (1930-1980), the adoption of, among others, different glass plates, heating systems, electric lighting and irrigation systems, fundamentally transformed the greenhouse horticultural sector. In the 1930s, greenhouse horticulture was comparable with outside arable farming in that it was dependent on the season and highly influenced by natural factors. In contrast, in the 1980s greenhouses are high-tech sealed-off biotopes where farming practices are very different from outside arable farming (Berkers and Geels, 2011).

Following Berkers and Geels' (2011) study, the system change within the horticultural sector should be typified as a reconfiguration pathway, where novelties, developed in niches, are generally adopted when found beneficial. Socio-technical change is triggered when: "regime actors explore new combinations between old and new elements" (Geels and Schot, 2007 p. 411).

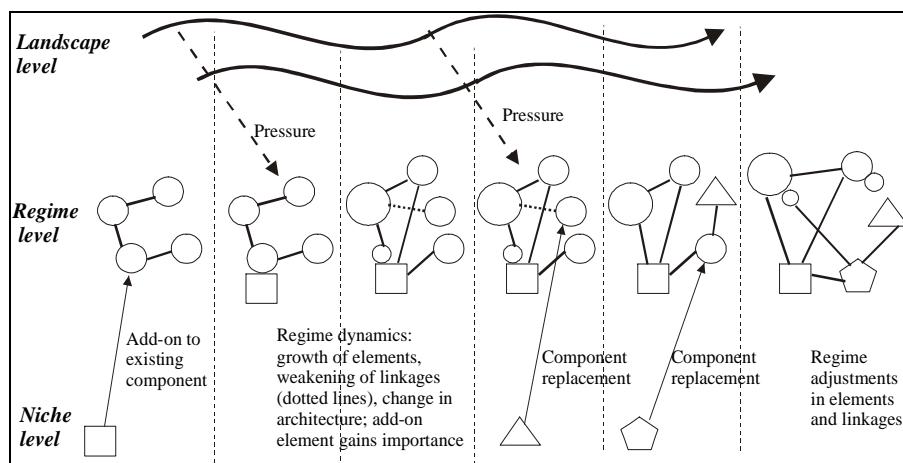


Figure 1.2: representation of reconfiguration pathway (Geels and Schot, 2007, p. 412).

Figure 1.2 represents the reconfiguration pathway and illustrates that "radical innovations are initially developed in niches. If they have symbiotic relations with the regime, they can be easily adopted as add-on or component replacement. (...) The new regime grows out of the old regime (...) by sequences of multiple component-innovations" (Geels and Schot, 2007 p. 411). The square, triangle and

pentagon at the niche level symbolise novelties. These novelties gradually replace specific elements within the existing socio-technical system (displayed as regime level) to solve a local problem. Over time the integration of diverse novelties may eventually amount to a fundamental change within the structure of the socio-technical network (i.e. system innovation).

Assuming that the reconfiguration pathway is applicable to the entire agricultural sector, the topic of diffusion of novelties is highly relevant, as wide usage of add-on novelties is needed to achieve a cascade of change throughout the sector.

### Diffusion of Novelties

Scholars that study the process of diffusion of innovations argue that the rate of adoption of novelties by actors follows a standard deviation curve when plotted over a long period of time (Rogers, 2003). Figure 1.3 represents this standard deviation and illustrates that adoption of novelties first proceeds slowly. The actors who first adopt the novelty are referred to as innovators. Innovators comprise a small group, not more than 2,5% of the total diffusion population. Next, the rate of diffusion increases: actors who adopt during this period are named early adopters (around 13,5% of total adopters). The rate of diffusion peaks when the early majority and late majority (together 68% of total adopters) adopt. Diffusion rate slows down when the last group, the laggards, adopt (Rogers, 2003).

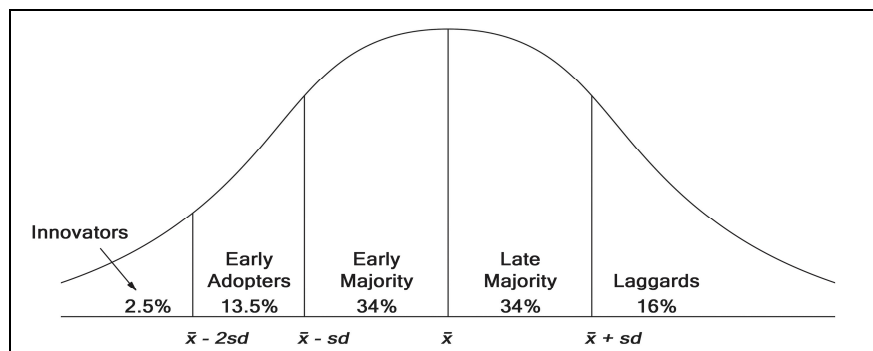


Figure 1.3: adopter categorisation on the basis of innovativeness (Rogers, 2003, p. 281).

### The Study of Niche Development to Aid Practice

The issue of which specific tensions and opportunities key actors experience during (system) innovation trajectories is marginally discussed by Geels (2002; 2005),

Geels and Schot (2007) and Rogers (2003) as these studies, like many others, focus on providing analytical models without paying detailed attention to the practical processes of developing, implementing and using novelties. Following the work of Collins (1992), Regeer et al. (2011, p. 52) remarks that: “the more distant one is (in space, time, and in a social sense) from the locus of a process, the more certain, linear, deliberate and neat the process will appear”. As a result, the complexity of the actual development process of an innovation could easily be underestimated.

Several system innovation scholars, however, embarked upon the study of ‘niche development’ in order to provide further understanding of the practice of system innovations, thereby offering guidance to policy makers and practitioners. This resulted in the development of transition management (Loorbach, 2007; van den Bosch, 2010), reflexive design (Bos and Grin, 2008), and strategic niche management (Schot and Geels, 2008; van Mierlo, 2002).

### *Transition Management*

Transition management aims to break with linear planning and policy models as these do not suit the complex, uncertain and long-term nature of system innovations (Rotmans and Loorbach). Loorbach (2007) argues that long-term, flexible visions are essential for creating momentum for immediate action. He proposes four iterative clusters of activities. The first focuses on problem structuring and the development of guiding visions on the future. The second entails coalition building and agenda setting. The third concerns establishing and carrying out transition experiments. The fourth is monitoring, evaluating and learning lessons from the transition experiments and, based on these, adjust the vision, agenda and coalitions. Transition Management, however, pays little attention as to how visions on the future (1<sup>st</sup> phase) influence transition experiments (3<sup>rd</sup> phase).

### *Reflexive Design*

Reflexive design is a design methodology that focuses on developing novelties in which values of diverse actors are inscribed (Bos and Grin, 2008; Grin et al., 2004). During the construction of reflexive designs, designers interview divergent stakeholders to gain insights into diverse perspectives, needs and interests. So far, several reflexive design projects which resulted in numerous innovative designs for livestock production farms, referred to by playful names like ‘Houden van Hennen’

(Loving and Keeping hens), 'Kracht van Koeien' (Cow Power), 'Varkansen' (Pig Opportunities) and 'Comfort Class'. The idea behind such designs is that if and when these Reflexive Designs are implemented by farmers it will compel them to act in a way that is more environmentally, economically and socially beneficial than the practices within current livestock production farms. Bos (2008), Grin (2008) and Koerkamp (2008) elaborate on the methodology of reflexive design. In addition, they reflect on the character and challenges of reflexive design projects. Although these studies provide better understanding of the reflexive design processes, they do not elaborate on the role or value of these designs in achieving actual system change in the agricultural sector.

### *Strategic Niche Management*

Schot and Geels (2008, p. 542) emphasise "the importance of 'hands-on', real-life experiences in demonstration projects" to further system innovations. Researchers who apply strategic niche management, study socio-technical projects and the niche level in which these are embedded (van Mierlo, 2002) to investigate strategies for successful niche development (Schot and Geels, 2008). Strategic niche management "focuses on understanding the early adoption of new technologies with high potential to contribute to sustainable development" (Schot and Geels, 2008, p. 538).

The strategic niche management literature distinguishes three courses of actions as highly important for the development of a niche, these are: (1) articulating expectations and visions; (2) building of broad social network; and (3) facilitating learning (Schot and Geels, 2008 referring to; Elzen, Hoogma, and Schot 1996; Kemp, Schot, and Hoogma 1998). They specify for the first course of action that visions should be developed that are broadly shared, concrete, and not too futuristic. Such visions would contribute to successful niche building and guide practical projects. For the second course of action it is argued that the social networks around the novelty should be: (a) broad in terms of multiple kinds of stakeholders, and (b) deep in terms of commitment. Similar arguments are used for the third course of action (collaborative learning) as it is advised that (a) learning should be broad; not only focussed on technical specifications, but also on market and user preferences, as well as societal and environmental impacts, and (b) learning should be deep in the sense that it also "contributes to changes in cognitive frames and assumptions" (Schot and Geels, 2008, p.541).

Scholars advocating strategic niche management readily recognise the practical complexity of bringing about a system innovation as they advise “generating more appreciation and reflexivity about the ongoing dynamics” (Schot and Geels, 2008, p.548). This can be done by, among other things, “helping policy makers build competences in recognising and dealing with policy dilemmas”. In addition, Schot and Geels (2008) note that strategic niche management has been used primarily for ex-post evaluation of case studies and that it remains questionable to what extent strategic niche management can be used in a prescriptive way.

### **Reflecting on System Innovation Studies**

I already indicated above that many studies in the field of system innovation investigate the entire long term system innovation process and therefore overlook to question which specific tensions and opportunities actors experience within niches. Studies that do focus on the interactions of actors within niches focus either on: developing visions of the future (i.e. transition management); developing new farm designs (i.e. reflexive design), or; developing demonstration projects (i.e. strategic niche management). As such the issue of what precisely happens during the phase of developing and implementing a prototype in the market context and the phase of initial diffusion (implementation of first dozen novelties after prototype implementation) of novelties is not investigated.

Furthermore, through ex-post evaluation, strategic niche management tries to provide guidance to actors in niches by primarily pointing out which conditions favour system innovations. Regeer’s study (2009) elaborates on how actors in innovation projects perceive such feedback. She states that project coordinators of innovation projects: “expressed agitation and annoyance with being confronted repeatedly with the gaps between programme theory and their practice. They argue they know about the theory but struggle with the implementation” (Regeer, 2009, p.115). Coordinators of innovation projects plead for direct engagement by scholars and assistance with reflection exercises throughout the innovation trajectory.

In section 1.3 I will argue that in order to raise our understanding of agricultural system innovations and to improve our guidance of agricultural innovations projects, we should look at the *interactions* between the *actors* and the *novelties* during the phases of developing and implementing a prototype in a market context and the phase of initial diffusion (implementation of first dozen novelties after

prototype implementation). A research field that has a rich tradition in studying the interactions between actors and novelties with the aim to gain further understanding into technology development is the field of technology studies. Below I first briefly discuss several key concepts within this field of technology studies before posing the research questions that guided my research.

### **Clarifying the Concepts of Actants and Inscription**

Scholars within the field of science and technology studies have looked at the development of artefacts in great detail. Since the prehistoric age, humans have crafted tools such as stone axes and clothing to solve problems or address needs. Over time the accumulation of technologies resulted in a society that can be considered as a socio-technical network (Bijker, Hughes and Pinch, 1987; Bijker and Law, 1992) in which humans and artefacts continuously interact with each other to fulfil functions. For example, in the agricultural production network farmers interact with crops, machines, employees and distributors to produce and sell food. Hence, science and technology scholars argue that technologies can not function, and can therefore not be studied, as artefacts in isolation. Latour (1987) takes this perspective rather far as he argues to discard the distinction between actors and artefacts and perceive both as actants that interact in a network. I recognise that actors and artefacts can not be studied in isolation; however, for analytical reasons I make a distinction between actors and artefacts. Before I explain how I will use these concepts in my research, I first elaborate on how technology steers actors and second on how actors steer technology.

First, technology steers our everyday action: cars, roads, bicycles, and public transport highly influence the route we take to move ourselves from one location to another. Akrich (1992) argues that: “like a film script, technical objects define a framework of action together with the actors and the space in which they are supposed to act” (Akrich, 1992, p. 208). Inscription is the process in which designers, engineers, innovators, and manufactures inscribe their desired pattern of action in the object (Akrich and Latour, 1992). Akrich and Latour (1992) use the following metaphor to explain inscription: a hotel manager adds a metal weight to the keys of the hotel rooms to motivate customers to return their key to the desk (Latour, et al., 1992). Bunders (1994) describes an example of inscription within the agricultural sector. Researchers at the University of California bred a new ‘hard’ tomato variant which was suitable for machine harvesting. The ‘hard’ tomato was: firm to sustain the force of the machine, detached easily from the

vine, and all the tomatoes ripened at approximately the same time. The introduction of the 'hard' tomato in California (1962) had wide-ranging effects: within nine years the number of tomato farms in the region dropped from 4000 to 600. Also 30.000 tomato pickers were replaced by 1.152 harvesting machines. Alternately, if actors are able to inscribe more broady *desired* patterns of action in the novelties and integrate these within the socio-technical network, a more sustainable sector may be developed.

Second, actors steer technology. Feenberg 's (1995) study on the development of videotex (precursor of the Internet) and Pinch and Bijker's (1984) case study on the public introduction of bikes illustrates this. Feenberg describes that the French government supported the development of videotex (i.e. Teletel) as they expected it 'to bring France into the information age' (Feenberg, 1995, p. 149). However, in practice users applied and thereby shaped the videotex in unexpected ways, for example to share sexual fantasies. Pinch and Bijker's (1984) historical case study on the introduction of bikes strengthen the notion that users' preferences shape technology. Their study shows that different social groups, such as woman cyclists, sport cyclists, elderly cyclists and tourist cyclists all assigned a different meaning to the bicycle. Bikes were framed, among others, as sport equipments and transport tools. The term *interpretative flexibility* was introduced to refer to the phenomenon that new technologies are open to more than one interpretation and that the framing and consequently the shaping of an artefact depends on the eye and context of the observer. *Closure* occurs when the artefact reaches its final form and stabilises (Pinch and Bijker, 1984).

Thus, actors and technology continuously interact and therefore shape each other. This perspective contrasts with the linear innovation model of basic research --> applied research --> technological development --> product development --> production --> usage. Pinch and Bijker (1987) suggest replacing the linear perspective with a 'multi-directional' perspective of technology development that entails alteration of variation and selection.

Agricultural system innovation takes the multi-directional nature of technology development into account. It entails replacing existing artefacts within the current agricultural socio-technical network as well as reconfiguring the network of actors. Historical examples include the transition from scythe (i.e. reaper) to combine-harvester and the related changes in work force. To achieve such system innovations, linkages between actors and artefacts need to be broken down and



new ones need to be assembled. How are such reconfigurations realised in practice? In the next section I propose to open-up the black box of the development and implementation of novelties in niches and in market contexts by exploring the interactions of actants in innovation projects.

### 1.3 Research Questions

In line with the theoretical perspective sketched above I perceive the agricultural sector as a socio-technical network. To contribute to the theoretical understanding of agricultural system innovations and to broaden our understanding of the guidance of agricultural innovation projects, I explore the actors and artefacts and their interactions in five innovation projects. By *actors* I mean the innovation project participants (e.g. agricultural entrepreneurs, researchers, project coordinators, civil servants) as well as the stakeholders in the broader network (e.g. community members, representatives of NGOs, politicians). Specific configurations of *artefacts* in my research are what I have called *novelties*: new technologies, processes or products that are experimented with in niches. The two novelties that I have looked at are:

- the Agropark: a network of farms, pigs, mushrooms, industrial plants, greenhouses, waste streams, bio-energy plants, air filters etc. (see box 1.1, page 36) and;
- the (semi) Closed Greenhouse: a network of glass, heat exchangers, orchids, aquifers, air ventilation systems, tomatoes, etc. (see box 1.2, page 37).

Next to the dimension of actants (i.e. novelties and actors), my research can be organised along the chronological dimension of the (system) innovation trajectory, while recognising that this is not a linear but a multi-directional process. I observed this trajectory from the *development* of a prototype of the novelty (e.g. activities of actors who aim to design an Agropark on one specific site in a market context), via efforts to *implement* a prototype of the novelty (e.g. activities of actors who aim to implement an Agropark on one specific site in a market context) to the *initial diffusion* of the novelty (e.g. the first dozen actors who implement and use a (semi) Closed Greenhouse after the usage of the prototype). The phrase prototyping is used to refer to the phase in which actors develop and implement the novelty for the first time in a market context (no prior experience exists). For clarification, I did not observe the origins or initial development phase of the novelties in the research context (i.e. the phase in which actors developed a broad vision of the novelties Agroparks and (semi) Closed Greenhouses, execute not

locally embedded feasibility studies, test models, or demonstration projects (in Dutch: 'proeftuin'). Neither did I observe the early adoption phase or take-off of diffusion of novelties (by early adopters and early majority implement and use novelty). Rather, my research focuses on a specific phase of system innovation processes: from the stage in which novelties are, for the first time, developed and implemented in a market context to the phase in which the first dozen actors implement and use the novelty after the prototype (i.e. initial diffusion).

How does the scope of my research relate to Rogers' (2003) model of diffusion of innovations? Rogers defines the first group of actors who adopt a novelty as innovators (see figure 1.3, page 20). Innovators comprise 2,5% of the total population that eventually implement a novelty. In this study I specify these innovators as follows:

- Innovators:

- Prototypers: the actors who are the first adopters of a specific novelty (no prior experience exists).
- Initial innovators: the actors who are among the first dozen adopters of a specific novelty after the prototypers (little prior experience exists).
- Follow-up innovators: up to 2,5 % of the total population of adopters.

The group of actors that adopt a novelty after the innovators and comprise 13,5% of the total population of adopters are referred to as:

- Early adopters

The prototypers and initial innovators are a specific category of agricultural entrepreneurs. They are pioneers who are intrinsically motivated to shape novelties further and are in a business context that provides them with the opportunity to innovate.

Below, I first explain in what way I look at *novelties* in the phases of developing and implementing prototypes and initial diffusion. This results in three research questions. Second, I clarify in what way I will look at *actors* in the three phases (again resulting in three corresponding research questions). As argued above, I expect that looking at innovation projects from these perspectives (novelties and actors on the one hand, and the three phases of the innovation trajectory on the other) will increase our understanding and provide theoretical insights in agricultural system innovations. Next, I will formulate three research questions on the practical guidance of innovation projects in each of the three phases. The resulting nine research questions are summarised in Table 1.1 on page 33.

**a. Looking at Novelties**

With system innovation programmes (and consequently with innovation projects) the Dutch government aims to support the development of new technologies, products, and processes (i.e. novelties) that induce more sustainable behaviour of actors. If actors are able to *inscript* desired patterns of action in the novelties and integrate these within the socio-technical network, a more sustainable sector could conceivably be the result. When examining studies in the field of reflexive design (i.e. shaping desirable design of novelties by inscribing various values) and social construction of technology (i.e. users shape technology) the question emerges to what extent it is possible to steer the development of novelties in a 'sustainable' direction. In order to understand the potential impact of a novelty in the long run, it is highly relevant to gain more insight into the very process of developing a prototype. Who were involved? How did the involvement of certain actors affect the shape of the specific prototype? How were certain values inscribed, and what happened to inscribed values over time in the development process? This leads me to pose the following question:

Question 1.a:

What do the interactions of actants in innovation projects during the development of a prototype disclose about the dynamics of shaping novelties?

In the innovation trajectory, after a novelty is framed as a concept of a prototype (e.g. the design of a local Agropark), it has to be implemented at a specific site, in a specific context, by local actors. This implies that the sheltered place (the niche) in which the novelty was developed is opening up. The process will be affected by the prevailing norms, habits and routines of concerned actors and vice versa. How exactly the novelty and the regime affect each other in the implementation phase is as yet underexplored. Is the relationship between novelties and the regime symbiotic (the novelty fits into the current agricultural domain) or competitive (the novelty conflicts with the current agricultural domain)? And what does this imply for the implementation of a prototype of a novelty? This leads to the following question:

Question 2.a:

What do the interactions between innovation project participants and stakeholders within the broader network reveal about the relation between novelties and regimes during the phase of implementing a prototype?

After the novelty has been developed into a real, functioning, Agropark or (semi) Closed Greenhouse, it should be implemented more frequently if it is to realise an actual change in the agricultural sector. As I noted before, the topic of wider diffusion of novelties is marginally discussed in system innovation studies. In Geels and Schot's (2007) *system innovation pathways*, novelties are depicted as static objects that do not change over time (see the square, triangle and pentagon depicted in figure 1.2 on page 19). Also, they refer to novelties as something that is *added-on* to the system or that *replaces* an existing *component* of the system. Add-ons and component replacements are then depicted as *closed* pieces of equipment. With *closed* I refer to Pinch and Bijker's (1984) idea of 'closure': the stage in which the artefact reaches its final form and stabilises. The question arises if such a representation characterises novelties during the phase in which the initial innovators implement and use the novelty. This leads to the following question:

Question 3.a:

What do the interactions of actants in the network of initial innovators that implement and use a novelty after the realisation of a prototype uncover about the nature of novelties?

#### ***b. Looking at Actors***

Elzen et al. (2008) emphasise that within the agricultural sector most novelties are introduced by pioneering farmers. This observation contrasts with the general notion within innovation studies that novelties are predominantly introduced by actors who are new entrants (outsiders). In my study I will take a closer look at who introduces novelties to shed light on this apparent inconsistency in theory (see **chapter 6**). Next to the pioneering farmers, other actors may also play an important role in the phases of developing and implementing a prototype; e.g. scientists, intermediaries, government officials, etc. Who are they and what role do they play? How do their actions affect each other? And how does collaboration take place? How do they learn? Furthermore, Geels and Schot (2007) distinguish '*niche actors*' and '*regime actors*'. However, they do not explicitly specify what precisely is meant with niche- and regime-actor. To gain more insight into the types and roles of the different actors involved in the development of prototypes of novelties, I formulate the following question:

Question 1.b:

What do the interactions between innovation project participants reveal about the role of actors in niches during the phase of developing a prototype?

In the phase of implementing a prototype, the number of involved actors increases, ranging from the local agricultural entrepreneurs, via neighbours and local politicians to (inter)national interest groups. Strategic niche management argues that innovation projects should develop a social network of multiple types of stakeholders who are highly committed (Schot and Geels, 2008). The question is whether it is realistic and even desirable that all actors who are part of this broad network of the innovation project are deeply committed. Moreover, Hendriks and Grin (2007) show that in practice there will sometimes be actors who oppose the aims of the innovation projects. As the actors within the broader network of novelties play very different roles, it is useful to make an analytical distinction between the innovation project participants on the one hand and the stakeholders within the broader network of the innovation project on the other. When studying the relationships between these actors during the implementation of a prototype, the following question emerges:

Question 2.b:

What can be concluded from the interactions between innovation project participants and stakeholders within the broader network about the role of the different actors within, and their influence on, the process of implementing a prototype?

A group that plays a centrale role in the wider diffusion of novelties are the initial innovators. Initial innovators are needed to further introduce novelties in the socio-technical network. What do the experiences of initial innovators during the trajectory from deciding to implement such a novelty until usage reveal about the process of reconfiguration? And more specifcly: what motivates actors to implement a novelty directly after the implementation of a prototype? And, what hampering factors do initial innovators encounter? To address this I formulated the following research question:

Question 3.b:

What do the interactions of actants during the implementation and usage of novelties reveal about the role of initial innovators during the phase of initial diffusion of novelties?

### ***c. Suggestions for Guiding Innovation Trajectories***

In addition to contributing to theoretical understanding of agricultural system innovation, my research aims to provide some indications on how to guide innovation projects. Facilitating innovation projects is challenging; multiple actors are involved with diverse views, commitments and ambitions. In addition these actors are used to express themselves in different jargons and are influenced in a more or lesser degree by their respective institutional settings. Moreover, the projects take place in a dynamic context which presents opportunities as well as obstacles – sometimes foreseen, but more often unexpected. Such a context makes it challenging to develop and implement prototypes and to implement and use a novelty in the phase of initial diffusion.

Strategic niche management argues that inter-institutional collaboration and learning is needed (Schot and Geels, 2008) to further develop novelties after the initial research and development phase. Regeer (2009) argues that in practice productive inter-institutional collaboration and learning is not effortlessly established since traditionally, scientists, entrepreneurs, policymakers, end-users and other social parties do not interactively co-create novelties. It needs to be noted that within the Dutch agricultural domain there is a rich tradition in which researchers and agricultural entrepreneurs cooperate to match knowledge demand to knowledge supply (Vijverberg, 1997). However, prototyping requires interactive co-production and co-creation between researchers and entrepreneurs. Regeer (2009) concludes that strategies for inter-institutional collaboration that adequately accommodate the mono-disciplinary background, routines, and competences of participants need to be developed in *action*. In this thesis I compare the *actions* of three innovation projects regarding inter-institutional collaboration and learning (specifically science-practice collaboration) to distil lessons for inter-institutional collaboration and learning leading to the following question:

Question 1.c:

What do the experiences of the innovation projects tell us about how to facilitate inter-institutional collaboration and learning?

Attempts to implement a prototype pose special challenges to facilitators of innovation projects. How can these facilitators acknowledge, and where possible accommodate, the diverse perspectives and interests of the growing network of

concerned actors? And how can they cope with the problems that arise if novelties conflict with current legislation? And how to balance between levels of inscribed ambitions and the commitment of entrepreneurs? These issues lead to the following research question.

Question 2.c:

What do the experiences of the innovation project tell us about how to facilitate the process of implementing a prototype of a novelty?

I noted above that numerous actors need to implement novelties to be able to eventually achieve wider diffusion and thereby a cascade of change throughout the agricultural sector. However, in practice most agricultural entrepreneurs prefer to wait with implementation until more experience is obtained, as it is risky to implement a novelty in the phase directly after prototyping. Initial innovators do take these risks and their experiences can provide insights in what this groups needs to support the implementation and usage during the phase of initial diffusion. My final question aims to disclose these insights in order to provide suggestions to current innovation policy:

Question 3.c:

What do the experiences of initial innovators tell us about how policy could stimulate the initial diffusion of novelties?

In chapter 6 I summarise the different suggestions for guiding the development of a prototype, via the implementation a prototype, to the initial diffusion, that emerge throughout the chapters of this thesis.

Table 1.1 provides an overview of the research questions combining the two dimensions of actants with the innovation trajectory. Questions in the light grey columns relate to the first research objective (improving theoretical understanding). The questions in the right hand column refer to the second research objective (improving options for guiding).

Table 1.1. Overview of research questions.

| Dimension<br>Phase       | Novelties   | Actors   | Guidance   |
|--------------------------|---|--|--|
| Developing a prototype   | 1.a<br>What do the interactions of actants in innovation projects during the development of a prototype disclose about the dynamics of shaping novelties?   | 1.b<br>What do the interactions between innovation project participants reveal about the role of actors in niches during the phase of developing a prototype?  | 1.c<br>What do the experiences of the innovation projects tell us about how to facilitate inter-institutional collaboration and learning?      |
| Implementing a prototype | 2.a<br>What do the interactions between innovation project participants and stakeholders within the broader network reveal about the relation between novelties and regimes during the phase of implementing a prototype? | 2.b<br>What can be concluded from the interactions between innovation project participants and stakeholders within the broader network about the role of the different actors within, and their influence on, the process of implementing a prototype? | 2.c<br>What do the experiences of the innovation project tell us about how to facilitate the process of implementing a prototype of a novelty? |
| Initial diffusion        | 3.a<br>What do the interactions of actants in the network of initial innovators who implement and use a novelty after the realisation of a prototype uncover about the nature of novelties?                               | 3.b<br>What do the interactions of actants during the implementation and usage of novelties reveal about the role of initial innovators during the phase of initial diffusion of novelties?  | 3.c<br>What do the experiences of initial innovators tell us about how policy could stimulate the initial diffusion of novelties?              |

The nine questions introduced in the above table form the overall scope of this thesis. I will present answers to these questions in chapter 6. These questions are not posed in this form in chapters 2 to 5; rather, in these chapters more specific research topics are identified that relate to the broader questions introduced above. As such, this chapter (chapter 1) can be seen as an overall theoretical frame that relates the specific studies that are explored in chapter 2 to 5. In chapter 2 to 5 I will clarify each specific focus and relate it to the nine questions that I posed



above. In the conclusion of this thesis (chapter 6) I will further interpret the findings of chapter 2 to 5 to provide additional understanding into the questions that I posed in above.

#### **1.4 Methodology**

The five innovation projects in which I participated as 'ILA monitor' serve as case studies in the context of this thesis. A case study approach is appropriate for studying complex socio-technical phenomenon such as agricultural system innovations, as it takes into account the full spectrum of the phenomenon. Within the case study approach, researchers provide a deeper understanding of a certain phenomenon by presenting personal interpretations on a specified case. Below I firstly present the 5 cases that I studied and position them in the theoretical context of system innovation. Next, I describe the applied research methodology – the participatory *Interactive Learning and Action (ILA) monitoring* approach and specify the process of data collection and analysis.

#### **Introducing the Five Innovation Projects**

Each of the studied innovation projects centres around a specific *novelty* and innovation-*phase*. Flori-log-regie was designing a new logistics model for the European potted plants sector; C2C Agropark Flevoland was designing an Agropark in northeast Flevoland; New Mixed Farm and Biopark Terneuzen were designing and implementing an Agropark in Limburg and Zeeland respectively; Synergy stimulated the diffusion of a new type of greenhouse: the closed greenhouse. Boxes 1.1 and 1.2 explain the general concept behind the novelties Agroparks and Closed Greenhouses.

##### *Biopark Terneuzen*

Biopark Terneuzen is situated in the key harbour of the province of Zeeland. In 2006 Zeeland Seaport, Van de Bunt consultants, and TransForum initiated Biopark Terneuzen to explore the idea to couple in and output streams of existing industry with a new greenhouse complex of 240 ha. Other project participants were the Municipality of Terneuzen, Province of Zeeland, and the industrial companies of Yara (a chemical fertiliser plant), Nedalco (a bio-ethanol plant), Heros (a water purification plant), and Rosendaal Energy (a bio-diesel plant). Knowledge institutes that executed applied research included the Radboud University, WUR (LEI, A&F,

PPO), and VU University Amsterdam. More elaborate descriptions of Biopark Terneuzen are provided in **Chapter 2 and 3**.

#### *C2C Agropark Flevoland*

Project participants of C2C Agropark Flevoland investigated how input and output streams of currently operational farms in the Noordoostpolder region could be interconnected. PPO (WUR) and Origon were the project coordinators. Furthermore, ten farmers with operated greenhouses, dairy farms, arable farms, a flower bulb farm and a seed material company joined the project (de Wolf, 2011). Most energy was directed at trying to develop a business plan in which entrepreneurs wanted to invest. The project team employed their wide political and business network within the region to catch the attention of actors within the policy and finance domain. In **Chapter 2** C2C Agropark Flevoland is analysed.

#### *Flori-log-regie*

Historically the Dutch auctions and traders have been a hub in the international logistics of potted plants. In the project Flori-log-regie the management of two auction houses who during the project merged into FloraHolland, businesses (Koninklijk Tuinbouwbedrijf Lemkes and HBAG) and representatives of traders (VGB) and the transport sector collaboratively explored concepts of new logistics models. An employee of Rijnconsult was the project coordinator. Furthermore researchers of Wageningen UR (University and the research institutes A&F, LEI) and Erasmus University participated. Flori-log-regie is presented in **Behind the Scenes 2**.

#### *New Mixed Farm*

In New Mixed Farm (NMF), several farmers and a director of the processing company Christiaens Engineering and Development BV aim to cluster a new large-scale pig farm, a large-scale broiler farm, a slaughterhouse and a bio-energy power station in a more or less closed system. The intended location of New Mixed Farm is the municipality of Horst aan de Maas, in the south-east of the Netherlands. The project coordinators are members of staff of Knowhouse. Other participants include; researchers of Wageningen UR (A&F, LEI) and TNO, consultants (Arcadis) and politicians and civil servants from different departments on national, regional and local level. In **Chapter 3** the initial design-phase of New Mixed Farm is

described and in **Chapters 2 and 4** the implementation history of New Mixed Farm (until 2010) is presented in detail.

### *Synergy*

The Synergy project aims to speed-up the diffusion of the closed greenhouse. The project coordinator is a self-employed consultant. Furthermore researchers of Wageningen UR (PPO, LEI) participate. The project team broadly communicates about the closed greenhouse, searches early adaptors and intermediates- and facilitates collaborations between growers, researchers and civil servants. Another key activity of Synergy was facilitating 6 weekly platform meetings with growers that implemented closed greenhouses or that have the intention to implement a closed greenhouse. These meetings function like a community of practice (Regeer and Bunders, 2003; Wenger, 1998): growers share experiences and consult each other with the aim of improving their work. And Synergy is further discussed in **Chapter 3 and 5**.

#### **Box 1.1: Agropark**

An Agropark is an area where different types of high-tech agricultural and industrial functions are clustered to create closed energy and nutrient cycles (Engelbart and de Wilt, 1998). The Agropark concept uses the principles of industrial ecology: the notion that we should transform our production methods in such a way as to optimise production and minimise waste (Huber, 2000).

The core principle of the Agropark concept is that by incorporating livestock breeding, crop production, slaughterhouses, and industry such as bio-power plants, diverse nutrient, waste, and logistic flows can be integrated (de Wilt et al., 2000; Grin and van Staveren, 2007). Agricultural businesses that apply a somewhat 'industrial' approach and do not require extensive areas of land (e.g. not arable farming), such as pig husbandry, poultry, and greenhouses, are considered well suited for Agroparks (de Wilt and Dobbelaar, 2005). Agroparks have a comparatively large size to make the required infrastructural investments that are needed to connect waste flows and the integrated agricultural chain functions commercially viable. Smeets (2009) describes an Agropark as: 'a spatial cluster of agrofuctions and the related economic activities. Agroparks bring together high productive plant and animal production and processing in industrial mode combined with the input of high levels of knowledge and technology' (2009, p.21).

**Box 1.2: Closed Greenhouse**

Greenhouses aim to provide a suitable crop climate in all seasons. In winter, natural gas is used to heat the greenhouse. In summer, the windows of the greenhouse are opened to loose excess heat.

In 2001, Henk van Oosten and Henk Huizingen (Grin and Staveren, 2007) discuss their idea to create 'energy producing greenhouses' with diverse experts in the field. By using a different process to warm and cool the greenhouse, heating with natural gas becomes obsolete. The main parties involved in the development of this pilot greenhouse system were Innovation Network, Dutch Foundation of Greenhouse Innovation (in Dutch: 'Stichting Innovatie Glastuinbouw Nederland' (SIGN)), Wageningen University and Research Centre (research institute) and Innogrow (company). This greenhouse uses excess heat in summer to be used in winter. Heat exchangers harvest excess summer heat by warming cold water that runs through small tubes. The warmed water is stored underground and used as a source to heat the greenhouse in the winter. The system includes two underground water basins (aquifers); one with warm water and one with cold water. This makes it possible to create a yearly cycle. During summer, cooling happens through ventilating cold air that is created with the stored cold water. This water subsequently warms. During winter, the water stream reverses. Now, hot air is produced and ventilated. Subsequently, cold water is created, which is used for the upcoming summer. Because this novel heating and cooling system makes opening the windows of the greenhouse obsolete, the novel greenhouse is referred to as the closed greenhouse. In addition to declining natural gas use, the closed system creates the possibility to keep carbon dioxide and humidity levels high. In open greenhouses, CO<sub>2</sub> and H<sub>2</sub>O evaporate through the open windows.

**The Case Studies in Theoretical Perspective**

When trying to position the innovation projects of TransForum within the theoretical context of the multi-level perspective model (p, X), it becomes apparent that innovation projects are embedded within niches (micro-level). Innovation projects can be regarded as a specific type of 'demonstration projects', a term used in strategic niche management (see page 22) or as a 'transition experiment', a term used in transition management (see page 21). Innovation projects aim to develop, implement, and scale-up specific novelties (i.e new products, processes, and technologies) that could contribute to fundamental changes toward a more sustainable agricultural sector. Moreover, innovation projects incorporate principles of transition management and strategic niche

management as actors from multiple domains participate and a 'learning by doing' approach is applied. A difference between the innovation projects that I studied and 'demonstration projects' as described by strategic niche management is that all five innovation projects took place in a market context while demonstration projects can also occur in public contexts (e.g. a university setting).

Another facet of the selected cases is the specific novelties that the innovation projects worked on: Agroparks and (semi) Closed Greenhouses. How do these novelties relate to system innovation theory? And how do Agroparks and (semi) Closed Greenhouses relate to each other? Some scholars of system innovation argue that Agroparks and (semi) Closed Greenhouses have the potential to trigger an agricultural system innovation (Elzen, Leeuwis and van Mierlo, 2008; Grin, van Staveren 2007; Smeets, 2009; Termeer and Dewulf, 2009). For instance, it is anticipated that implementation of these novelties will have a large impact on the configuration of the socio-technical network. Moreover, it is expected that adoption of these novelties will result in an agricultural production system that functions with less pollution than the established agricultural production system.

So, to what extent do Agropark and (semi) Closed Greenhouse relate to each other? First, both novelties involve high-tech constructions. Second, they were initially developed by researchers. Third, they can be perceived as being aligned to the design principles of industrial ecology: the notion that we should transform our production methods in such a way that production is optimised and waste flows are minimised (Huber, 2000). Fourth, the users of both novelties are primarily farmers.

The key differences between the novelties is that (semi) Closed Greenhouses can trigger system innovations within the horticulture sector. By contrast, Agroparks transcend the boundaries of the agricultural and industrial sectors and thereby can potentially induce system innovations throughout these sectors. In addition, the (semi) Closed Greenhouse is a more narrowly defined novelty with specific technological features whereas the Agropark is a broadly defined concept.

Furthermore, during the execution of this research, Agroparks and (semi) Closed Greenhouses were at different phases in the system innovation process. Whereas several (semi) Closed Greenhouses were already operational, only one Agropark had been partly established. As a result, I investigated the novelty Agropark during the phase of developing and implementing a prototype, and I studied the novelty

(semi) Closed Greenhouse during the initial diffusion phase (i.e. when the initial innovators adopt the novelty). As a consequence I explored experiences of the Agropark innovation projects to address questions 1.a, 1.b, 1.c, 2.a, 2.b and 2.c.; and I investigated the experiences of the initial innovators of the (semi) Closed Greenhouse, who participated in the innovation project Synergy, to address questions 3.a, 3.b and 3.c. For clarification, the experiences of inter-institutional collaboration and learning between researchers and entrepreneurs within the context of the Synergy innovation project were also taken into account to answer questions 1.b and 1.c, so that more experiences of innovation projects can be compared.

Another question that emerges is: why were these five innovation projects chosen as cases for study? During my research I applied a specific interactive learning and action (ILA) research approach. ILA builds on transdisciplinary (Caron-Flinterman, 2005; Klein, 2001) and (participatory) action research (Lewin, 1946) as it values the knowledge of non-researchers, such as farmers and patients, and aims to contribute to solving complex societal issues. As this kind of research is integrated in a social context that is inherently uncertain, ILA researchers apply an adaptive *en route* research approach. This implies that cases are not only selected on the basis of their appropriateness for generating knowledge in a specific field, but also on the basis of the needs of actors who work on complex societal issues. In my study I interacted within and studied five innovation projects that fitted my research objectives and welcomed my participation.

So, how was I introduced to participants of the innovation projects studied? The Athena Institute was given the opportunity by the innovation programme TransForum to study innovation projects with the aim to understand the interaction within innovation projects and to support the participants. As such a research team of the Athena Institute, in which I participated, further developed and experimented with the Interactive Learning and Action (ILA) *monitoring approach*, which Regeer (2003; 2009) started to explore in 2003. Below I explain the principles behind the Interactive Learning and Action *monitoring* approach and discuss how I applied this in five innovation projects.

### **Interactive Learning and Action *Monitoring* Approach**

Interactive Learning and Action *monitoring* approach is based on the Interactive Learning and Action (ILA) approach (see box 1.3 for a brief description of the ILA

approach). ILA monitoring is a type of evaluation approach that differs from other evaluation approaches such as goal-oriented programme evaluation and programme theory evaluation (Regeer et al, 2009). The underlying assumption of goal-oriented programme evaluations is that there is a firm casual (linear) relation between interventions and performance, and that these results can be measured. Such a perspective mis-matches with the system innovation perspective which emphasises that system innovations entail long-term, dynamic, and thus unpredictable processes. In addition, the goal-oriented evaluation approach is applied at the end of an intervention to assess its impact; thereby not providing feedback for improvement of performance.

Programme theory evaluation, on the other hand, investigates why certain interventions are set-up. It investigates the rationale behind the project's perceived problems, its intended interventions and expected results. A point of critique to programme theory evaluation is that the approach insufficiently takes into account the wide variation in perspectives and the adaptive nature of programmes. Furthermore, the consistency between the project's aspirations and the actions undertaken by participants, can be lacking. For example, 'demand-driven research' may be an explicit aspiration of the project, but in practice some project participants may act contrary to these intentions (e.g. executing basic and science-driven research). This phenomenon has been described as a discrepancy between the 'espoused theory' (intention) and 'theory-in-use' (practice) (Argyris and Schon, 1974). The discussion of Regeer et al. (2009) of the predominantly applied goal-oriented evaluation and programme theory evaluation approaches clearly demonstrate the need for a new evaluation approach, which focuses on the *theory* and *actions* of the inner-project "with the purpose of assisting in making timely adjustments" (Regeer et al., 2009, p. 521).

ILA monitoring addresses the need to interconnect evaluation and assistance. ILA monitoring focuses on the *inner workings* of the evaluated projects. Researchers that apply ILA monitoring are referred to as 'monitors'. ILA monitors investigate the inside of projects, rather than measuring the 'outside' impacts. This focus is chosen because performance measurement of project outcomes is incompatible with the context of agricultural system innovations, which are long-term processes in which many actors and institutions play a role and that go well beyond the scope of the evaluated project. The 'inside' perspective of ILA monitoring aligns with programme theory evaluation. An important difference between ILA monitoring and programme evaluation is that ILA monitoring not only assesses the

underlying assumptions of project participants but also observes and questions the practice (i.e. inside *working*) of the evaluated project.

An ILA monitor aims to assist the innovation project by stimulating reflection of project participants upon their actions and intervention strategies. Furthermore, the monitor aims to increase the relation between intervention *strategy* and *practice* by making explicit and questioning inconsistencies in an appreciative way (i.e. appreciative enquiry). Appreciative enquiry implies a constructive and exploratory approach and assists in creating a safe environment for project participants. This safe environment is essential for the articulation of and reflection on tough issues, such as difficulties, annoyances, conflicts and other struggles. As continually and bluntly confronting project participants with inconsistencies and problematic issues will most likely ‘overshoot the mark’ of assisting the project as the participants will get frustrated and discouraged.

For an ILA monitor, appreciative enquiry goes hand in hand with addressing tough issues that project participants tend to ‘sweep under the rug’. The ILA monitor specially attends to putting tough issues, such as activities that didn’t go so well, on the agenda. However some tough issues require more attention than reflection alone. The ILA monitor deals with these types of issues by organizing and executing an intervention. For example by facilitating work sessions in which project participants experience a new working approach. (An example of a work session is provided in **Behind the Scenes** (pages 75-100).

The focus on the ‘inside working’ does not mean that ILA monitors turn a blind eye to the project’s context (i.e. regime). As stated above (see also box 1.3), ILA especially attends to the surrounding context in which the project is embedded. An ILA-monitor addresses issues that go beyond the scope of the project such as (lack of) support of the home organisations of project participants (Regeer and Bunders, 2007).

Last, ILA monitoring is not a ‘method’ in the sense that it provides a blueprint to be used in any context. Instead, it is an Adaptive Evaluation approach, whereby monitoring activities are continually tailored and brought into alignment with the specific learning needs, competences, contexts, aims and phases of the investigated projects. Thus, ILA monitoring ensures a strong link between the *monitoring activities* and the *intervention strategy* of the evaluated project. Further theoretical grounding of the ILA monitoring is discussed in Regeer et al.



(2009). For an elaborate guide on ILA *monitoring* I refer to Regeer, et al. (2011) and van Mierlo, et. al. (2010).

**Box 1.3: Interactive Learning and Action (ILA)**

The Interactive Learning and Action (ILA) methodology combines qualitative and quantitative social research and participation, coaching and training. ILA focuses on the relation between science, technology, innovations and society.

Over the past twenty-five years, the Athena Institute (VU University Amsterdam) developed and experimented with the ILA approach to gain further understanding of the relationship between science, technology and society and at the same time to improve alignment between science and technology development and societal needs (Broerse, 1998; Bunders et al., 2010; Caron-Flinterman, 2005; Regeer, 2009; Regeer and Bunders, 2007; Roelofsen, 2011; Zweekhorst, 2004). The ILA approach was first introduced in developing countries in the 1980s and 1990s with the aim to adapt agricultural innovation to the needs and desires of small-scale farmers (Bunders and Broerse, 1991).

An important difference between the ILA approach and other participatory, transdisciplinary, and action oriented research approaches is that attention is given not only to the project and the competences of project participants, but also to the surrounding context (regime) in which the project is embedded (Broerse, 2001; Regeer, 2009; Zweekhorst, 2004). Since ILA includes the regime within the unit of analysis and is applied in transdisciplinary settings, it is an appropriate methodology for studying and assisting innovation projects that work on system innovations.

**Applying ILA Monitoring to the Innovation Programme TransForum**

TransForum formulated a '*set of motivating assumptions*' to which participating actors within innovation projects had to comply in order to be granted financial support. These principles are: "system innovation is a non-linear learning process [..and..] requires a multi-stakeholder approach [..which..] implies trans-disciplinary knowledge creation" (Latesteijn and Andeweg, 2011a, p. 13-14). In the resulting innovations projects, farmers, researchers, civil servants and public actors jointly pioneered to achieve new agricultural businesses with "better 3P performance" (Latesteijn and Andeweg, 2011b, p. 136).

In the summer of 2005, members of staff of TransForum discussed with the Athena Institute the issues that they struggled with: how to capture the learning

experiences of the innovation projects and how to embed the lessons learned within the projects. This was an important issue for the TransForum bureau because no blueprint exists for their task; in fact little prior experience exists with inter-institutional collaborations and learning which ultimately aim for sector-wide change. As such, the innovation projects can be considered as experimental spaces in which different strategies and approaches are developed. TransForum needed a methodology to evaluate their projects and make any lessons that could be drawn from them explicit. They found, however, that most of the currently applied methods were not well suited to their specific needs as they are based on a paradigm which includes (a) clear-cut, certain and shared objectives and (b) a strong causal relation between interventions and outcomes.

The Athena Institute took on the task to develop and apply an evaluation method that would better suit TransForum's *motivating assumptions* and the context of the innovation projects. This resulted in the further refinement of the ILA monitoring approach, to stimulate the learning of project participants with the aim to improve the effectiveness of their interventions and to seize the insights obtained through the experiences of the innovation projects (Regeer, 2009). I was the monitor for the innovation projects Biopark Terneuzen, C2C Agropark Flevoland, Flori-log-regie, New Mixed Farm, and Synergy<sup>1</sup>.

#### *My Role as Monitor in Five Innovation Projects*

In March 2006 I began my research as I started to explore monitoring activities in the innovation projects Biopark Terneuzen, New Mixed Farm and Synergy and, some time later, in Flori-log-regie and C2C Agropark Flevoland. Initially I applied the Learning History approach (Kleiner and Roth, 1996) to capture the learning experiences of the innovation projects. Numerous interviews were conducted, transcribed and labelled to create narratives in which the critical episodes during the process of the projects were documented. These narratives were analysed by

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<sup>1</sup> Throughout the five years of the collaboration with TransForum, the ILA monitor research team applied ILA monitoring within thirteen agricultural innovation projects (within and outside of the context of TransForum). I monitored five innovation projects and Dr. Barbara Regeer was, besides overall coordinator, the primary monitor for three innovation projects (Streamlining Greenport Venlo, Green Care Amsterdam and Biopark Terneuzen). In 2007 the monitoring team was extended with senior researcher Prof. Dr. Tjard De Cock Buning (LandMarkt, Green Education), post docs Dr. Volkert Beekman (Northern Frisian Woods, Agromere, Echt Overijssel) and Dr. Mariette van Amstel (Regional Food Chains), and junior researcher Renee Liesveld M.Sc. (Regional Food Chains).

myself and the project participants, providing the opportunity to collectively reflect on the experiences.

During the first few months of monitoring, I primarily *observed* project activities, *questioned* perspectives of project participants and *analysed* these ethnographic data together with project participants. In a later stage, as it became clear that addressing tough issues and reflection were not always enough to establish change of action, providing *advice* and *organising work-sessions* were added to the monitor's interventions.

Building on this preliminary ILA monitoring research, I advanced reflection upon the ILA-monitoring methodology and extended my monitoring activities. Reflection was strengthened by participating within several 'monitoring' networks. From 2006 onwards I joined: the CCT (Competition Centre Transition) Transition-Monitoring Network and participated in six meetings; the TransForum Monitorings Community of Practice and participated in seven meetings; the CCT platform Learning in Transitions and participated in over five meetings. Furthermore, in 2008 I was provided the opportunity to take part in a collaboration with the Communication and innovation Studies group at the Wageningen University to develop a guide for monitors. I assisted in the interviewing of four monitors and four project coordinators and co-authored the book (van Mierlo et al., 2010).

As ILA-monitor I enhanced my monitoring activities by, among others, providing quicker feedback to innovation project participants. In addition, I experimented with letting the project participants experience a new working approach by initiating and facilitating tailored work-sessions. An account of work-sessions that were executed within the projects Flori-log-regie is provided in the intermezzo **Behind the Scenes**.

The 'empirical core' of this thesis was built during my monitoring activities. Since our ILA monitoring approach (Regeer et al., 2009) is in line with ethnographic (Gellner and Hirsch, 2001) and Grounded Theory principles (Strauss and Corbin, 1990) much effort was invested in collecting a rich and accurate body of empirical data. For each of the five projects; key informant relationships were built: interviews with project participants and key stakeholders were conducted, project meetings and seminars were attended and workshops were developed and facilitated. Table 1.2 provides an overview of my involvement within the innovation projects. These data provide the basis for this study on Agricultural

system innovation. Next to this main focus, the intermezzo provides additional insight in the practice of ILA monitoring. Here I provide a peek into the work of a monitor. I entitled this section '**behind the scenes**' (pages 95-100).

Table 1.2: specification of monitor involvement within five innovation projects.

| Project                 | Involvement   | Documentation   |
|-------------------------|---|---|
| Biopark Terneuzen       | <p>Conducted:</p> <ul style="list-style-type: none"> <li>- 15 interviews with project coordinators, participating researchers and practitioners.</li> <li>- 1 presentation for core project team.</li> </ul> <p>Participated in:</p> <ul style="list-style-type: none"> <li>- 2 seminars for broad network of project.</li> </ul> | <p>Hoes, A.C, B.J. Regeer, and J.F.G. Bunders. 2008. <i>Transformers in knowledge production: building science-practice collaborations</i>. Action Learning: Research &amp; Practice 5 (3):207-220. (<b>Chapter 3</b> this thesis)</p> <p>Hoes (2008) van Onderzoek naar Innovatie? ervaringen met transdisciplinair onderzoek in Biopark Terneuzen. Internal report.</p> <p>Hoes (2006) Monitoringsverslag van Agribusiness Cluster Gent Terneuzen. Internal report.</p> <p>Hoes (2006) Monitoring van Agribusiness Cluster Gent Terneuzen. Presentation at Van der Bunt, Amsterdam (21 november 2006).</p> <p>Hoes (2008) TransFormers in Knowledge Production: Building science-practice collaborations. Henley-on-Thames, Groot-Brittannië: International Action-Learning Conference (18 March 2008).</p> |
| C2C Agropark Flevo-land | <p>Conducted</p> <ul style="list-style-type: none"> <li>- 10 interviews with project coordinators and participating farmers.</li> </ul> <p>Participated in:</p> <ul style="list-style-type: none"> <li>2 meetings of project team.</li> <li>1 visioning workshop for</li> </ul>   | <p>Hoes, A.C, B.J. Regeer, and J.F.G. Bunders. In review. Sustainable Development of Agriculture: Exploring the relation between future visions and bottom-up entrepreneurship in the Agropark case. Special issue of the Journal of Chain and Network Science. (<b>Chapter 2</b> this thesis)</p> <p>Hoes and Liu (2010) C2C Agropark in de Noordoostpolder. Movie. Athena Institute, Vrije Universiteit, Amsterdam.</p> <p>Alimahomed, R., van Benthem, J., Huizenga, H., Klinkenberg, M., van Scheepstal, I., Shatanawi, S., van der Spoel, I., Yntema, F., Zijl, L. (2009) C2C Agropark in de Noordoostpolder. Supervised by Anne-Charlotte Hoes. Internal document.</p>  |

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|                 | participating farmers.<br>1 seminar for broad network of project.  | Athena Institute, Vrije Universiteit, Amsterdam.<br><br>Liu, Y (2010) Een workshop aanpak om samenwerkingsproblemen in een beginnend project aan te pakken. Internship report supervised by A.C. Hoes.  |
| Flori-log-regie | Conducted:<br>-12 interviews with project coordinator, participating professionals and researchers.<br>-2 workshops.<br>1 to assists science-practice collaboration at project level.<br>1 to embed lessons learned on programme (TransForum) level.<br>-3 presentations for core project team, TransForum bureau, and at project seminar.<br><br>Participated in:<br>-6 meetings of project's steering committee<br>-2 seminars; for wide network of project. | Hoes, A.C, Regeer, B.J., Bunders, J.F.G. (2010) Facilitating Learning in Innovative Projects: Reflections on our experiences with ILA-monitoring. <i>Conference Paper for International Conference on Organizational Learning, Knowledge and Capabilities (OLKC). June 3-6, 2010. Boston, Massachusetts. (Behind the Scences this thesis)</i><br><br>Hoes (2009) Experiment voor kennis co-creatie, hoe wetenschap en praktijk samenkomen in Florilog-regie.<br><br>Hoes, A.C., Scheer, F.A. & Vollebregt, H. (2008). Flor-i-log regie, Werkpakket 3 Netwerkorganisatie. Athena.<br><br>Hoes (2010) Facilitating Learning in Innovative Projects: Reflections on our experiences with ILA-monitoring Presentation at Organizational Learning, Knowledge and Capabilities (OLKC) Conference: <i>Learning to Innovate, Innovating to Learn</i> (5 June 2010). Boston: Massachusetts, USA.<br><br>Hoes (2008) Lessen uit Florilog regie voor Shared Value Development . Zoetermeer: werksessie TransForum. (17 December 2008)<br><br>Hoes (2008) De geschiedenis van FloriLog-regie... ..en een blik vooruit! Presentation at FloraHolland, 23 June 2008, Aalsmeer.<br><br>Hoes (2008) Science-business collaborations in FloriLog Orchestration. Presentation at International conference on Management in Agrifood Chains and Networks (29 May 2008), Ede. |
| New Mixed       | Conducted:<br>-31 interviews,  | Hoes, A.C. and B.J. Regeer. In review. Adoption of New Land Use Facilities in a Normative Diverse Society: exploring the  |

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| Farm    | <p>with innovation project participants, and stakeholders who did not participate in the project.</p> <p>-2 workshops at project level to reflecting on issues of public resistance.</p> <p>-5 presentations, for core project team, steering committee, TransForum bureau and scientific conference.</p> <p>Participated in: -20 meetings of steering committee, project team, and task force.</p> <p>-3 public events; a public information meeting, a public debate and public city counsel debate.</p> <p>-1 seminar for project participants</p> | <p>New Mixed Farm case. Journal of Environmental Policy &amp; Planning. (<b>Chapter 4</b> this thesis)</p> <p>Hoes, A-C, Regeer, B.J., Bunders, J.F.G. 2009. Anticipating public protest in niche experiments. Conference paper. KSI Conference: Dynamics &amp; Governance of Transitions to Sustainability.</p> <p>Hoes (2009) Dynamische leeragenda Nieuw Gemengd Bedrijf. Internal project document.</p> <p>Hoes (2007) Notitie over de informatiebijeenkomst in Grubbenvorst en een analyse van de tegenargumenten van buurtbewoners. Internal project document.</p> <p>Hoes (2006) Monitoringsverslag van Nieuw Gemengd Bedrijf. Internal project document.</p> <p>Hoes (2010) Een reflectie op de gebeurtenissen van Nieuw Gemengd Bedrijf. Horst, Nederland (25 March 2010).</p> <p>Hoes (2009) Lessen uit Nieuw Gemengd Bedrijf voor Shared Value Development . Zoetermeer: werksessie TransForum. (6 July 2009)</p> <p>Hoes (2009) Anticipating public protest in niche experiments. Amsterdam, The Netherlands. KSI Conference: Dynamics &amp; Governance of Transitions to Sustainability (4 June 2009).</p> <p>Hoes (2007) Monitoring Nieuw Gemengd Bedrijf. Presentation during Steering committee of New Mixed Farm, 15 Januari 2007, city hall Horst aan de Maas, Horst.</p> <p>Hoes (2006), Een Leergeschiedenis van Nieuw Gemengd Bedrijf. Presentation for core project participants at KnowHouse, Horst (30 June, 2006).</p> |
| Synergy | <p>Conducted: -24 interviews, with project</p>  | <p>Hoes, A.C, V. Beekman, B. Regeer, and J.F.G. Bunders. In-press. Unravelling the dynamics of adopting novel technologies: An account of how the closed greenhouse opened-up.</p>  |

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|  | <p>coordinators (key informants), with participating growers, representatives of horticulture and civil servants.</p> <p>-1 workshop to assist project team with transdisciplinary communication.</p> <p>-7 presentations for core project team, steering committee, growers CoP, TransForum IAB, Graduate School and scientific conference.</p> <p>Participated in:</p> <p>-18 meetings CoP meetings of Growers, project meetings and steering committee meetings.</p> <p>-2 seminars for early adopters.</p> | <p>International Journal of Foresight and innovation Policy. <b>(Chapter 5 this thesis)</b></p> <p>Bakker, J.C., Maters, H.J., Kipp, J.A., Gieling, T.H., Hoes, A-C., (2009) <i>SynErgie, Eindrapportage Fase I en II</i>, Wageningen UR Glastuinbouw, Wageningen</p> <p>Hoes (2008) Een evaluatie van het tuindersplatform. Internal project document.</p> <p>Hoes (2007) Dynamische kennisagenda van Synergie. Internal project document.</p> <p>Hoes (2007) Notitie over de rol van de projectgroep Synergie. Internal project document.</p> <p>Hoes (2006) Monitoringsverslag van Synergy. Internal project document.</p> <p>Hoes (2008) Following system innovation projects. Ravenstein: The Netherlands Graduate School of Science, Technology and Modern Culture (WTMC) zomerschool. (26 August 2008)</p> <p>Hoes (2008) Learning in a Niche: A narrative of how the closed greenhouse opened-up. Wageningen: Conference Transitions Towards Sustainable Agriculture (27 October 2008).</p> <p>Hoes (2008) Learning for system innovations: A narrative of how the closed greenhouse opened-up. Amsterdam: International Advisory Board of TransForum. (25 November 2008)</p> <p>Hoes (2008) Leren van de tuinders verhalen over transitie. Ter Aar: tuindersplatform van Synergie. (10 November 2008)</p> <p>Hoes (2007) Reflectie Projectgroep. Presentation and working session for project participants Synergy at, Zoetermeer. 21 juni 2007.</p> <p>Hoes (2006) Monitoring &amp; Synergie. Presentation for core project participants at Productschap Tuinbouw, Zoetermeer (21 June, 2006).</p> |
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### Approaches for Securing Quality

I applied several strategies to assure the quality regarding my interpretations and conclusions. These are: (a) being precise and extensive in the collection of relevant empirical data by reordering and transcribing all interviews and work sessions. (b) Inquiring and analysing these empirical data by extensively and intensively moving back and forth between empirical data, theory, and own reflections. I used the qualitative coding system software ATLAS-Ti to assist the coding of the empirical data. (c) Improving initial interpretation through organising dialogue with colleagues, innovation project participants, peers, and practitioners, and (d) confirming accuracy of the presented data by asking coordinators of innovation projects to check manuscripts and (e) organising quality control on the consistency and strength of argumentations that are presented in the manuscript through scientific peer review feedback, as chapters 3 and 5 have already been published in peer reviewed journals.

Case studies are necessarily limited in terms of time-span, geography, and other factors. In each chapter I will be elaborate on a) the scope of the selected case, b) why the case was relevant for answering the main research question, and c) which questions steered the data analysis. Additionally, in each chapter I will make an explicit distinction between theory, data and my own interpretation in the presentation of the findings.

### 1.5 Outline of the Thesis

In this **introduction** I discussed the theoretical and practical context of this thesis and clarified my research approach. As indicated above, this chapter relates the specific studies that are explored in chapter 2 to 5. In this section I briefly introduce the scope of these specific studies.

In **chapter 2** I will indicate that system innovation theory argues that there is a relation between a top-down vision on the future and innovation projects. However, the issue of *how* such visions influence innovation projects is not yet well studied. In **chapter 2** the relationship between visions on the future and bottom-up entrepreneurship is explored by studying the interaction of actors in an Agropark visioning initiative and in four Agropark innovation projects.



As indicated above, strategic Niche Management stresses that inter-institutional collaboration and learning is highly important for innovation projects. However, Regeer (2009) notes that such collaboration is not easily established in practice. In **Chapter 3** I will compare the strategies that were applied in three innovation projects to shape science-practice collaboration and learning. This chapter provides guiding principles for shaping collaboration and shared learning in heterogeneous groups, like the stakeholder groups undertaking an innovation project. These guiding principles were fed back into a different innovation project (i.e. Flori-log-regie) by developing and organising a tailored workshop to improve the collaboration between practitioners and scientists. A detailed description of this workshop is provided in the intermezzo **Behind the Scenes**.

**Chapter 4** addresses the topic of dynamics of social acceptance during the implementation of a prototype. Studies in the field of spatial planning (Schively, 2007) indicate that since the 1980s innovators are increasingly confronted with dilemmas of public resistance when aspiring to implement a new facility, such as a farm, even when the facility results in a more sustainable practice. This phenomenon also occurred in one of the studied innovation projects, where implementation efforts were hampered due to public protest. To gain further understanding of the dynamic and struggles that emerge during the implementation of novelties, in this chapter I explore the interaction between innovation project participants and actors within the broader network during the implementation of the proposed Argopark New Mixed Farm.

The phase of initial diffusion of novelties in agricultural system innovation context is examined in **chapter 5**, where the interactions of initial innovators, who implemented the novelty (semi) Closed Greenhouse directly after the prototyping phase, are studied.

In **chapter 6** I investigate what general insights the specific studies of this thesis (chapters 2 to 5) provide on the theory and practice of agricultural system innovation. Findings regarding the interactions between actors and novelties within the network of innovation projects are related to the nine questions that I posed in table 1.1 (page 33). In the concluding remarks some suggestions for further research are provided.